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Lubrication

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EDITORIAL

IT has been a matter of interest to us to observe the increased number of articles upon lubricating matters which have appeared in the technical journals in the last year or so, and the very rapid increase in the number of articles upon the same subjects specifically applied to motors to be found in the general magazines.

It is evident that there is a general awakening to the importance of lubrication as a subject for study and investigation. Engineers, manufacturers, and all who have to do with the operation of moving equipment are realizing the tremendous waste of power due to the lack of consideration of the means required to overcome the frictional loss.

We have had occasion to observe, from time to time, the reluctance with which general interest is awakened in a conservation measure, in comparison with the interest which can be awakened in the same time upon a measure which introduces a new and visible improvement.

Of the two, however, there is no doubt that a greater efficiency in conservation means a larger total gain than a new improvement in the saving of labor by the expenditure of more power. The conservation improvement results in an increase in the amount of power from the same amount of fuel which can be turned to useful work, thereby making new possibilities available in the use of the source of the power.

These matters are, of course, particularly obvious where a plant is running up to its full capacity and apparently needs, in order to take care of more work, an extension of the plant itself and the equipment. Any measure of saving which can be made upon the waste of power in such a

case (consequently making some of this power available for new work) is of the utmost importance, particularly in these days when it is becoming increasingly difficult to secure the rate of profit upon capital invested to which the manufacturer has been accustomed.

The largest single factor in the waste of power in any plant using considerable moving equipment, is the loss of energy due to frictional resistance, and consequently any possibility of decreasing this loss is of the utmost importance.

Careful and thorough study of the question of lubrication, the character and properties of the oils most suitable for the work, the best mechanical arrangement for supplying the oil and using it, etc., present the largest possibilities in the saving of power which offer themselves to the manufacturer or manufacturing engineer.

Because of the fact that much of the waste of power due to poor lubrication is unaccompanied by any physical evidence thereof, it has been customary in a great many instances, to depend upon a comparison of the physical characteristics of the lubricant to be used without any careful and accurate tests of their operation under actual service conditions. No manufacturer would think of buying a machine tool, or other important piece of equipment, without testing the tool in actual operation, and in a sufficiently thorough manner to demonstrate beyond a shadow of a doubt its advantages and value. Yet, the failure of a single machine would be merely the stoppage of the spigot, compared with the continual losses which can flow away through the bunghole of lubricating waste.

It has been amply proved that the particular physical characteristics of any oil, or set of oils, cannot be used as a standard of comparison in measuring other oils for their service value. In fact, it has been amply demonstrated that the oils from various fields are sufficiently different in chemical composition, and consequently in physical characteristics, to make a comparison upon any such basis absolutely impossible.

Furthermore, investigation and examination of the action of different oils under service conditions has demonstrated the futility of many of the physical properties to explain such action.

The chemical composition and the physical properties of an oil are particularly interesting to the chemist because they indicate something of the products which will be found therein, and form the basis for his further experimentation. The engineer, however, who is not concerned with the analysis of the oil nor with the way in which such analysis affects the number and character of the products contained therein, can learn little, if anything, from the physical anaylsis usually employed. The only thing which is of any moment to him is the actual effect upon the working of his plant and the amount of money represented by the waste or the saving of one method of lubrication against another.

Furthermore, the mechanical conditions of the plant, the surrounding conditions, the local requirements in respect of labor and other matters, have a direct bearing upon the possibilities of saving through study of lubrication and the character of the lubricants which should be used to effect that saving.

When the manufacturer is buying lubrication, therefore, he should be buying, and is really buying, not only a lubricant of proper characteristics to suit the work, but an engineering service in conjunction therewith, which can determine the changes necessary to accord with the necessary local conditions of the plant and can show by actual test the service performed by the products.

This is something which cannot be secured upon specification because the specifications, besides suffering from the lack of any definite relation with the lubricating service, are inflexible and cannot be modified to suit local conditions or circumstances upon the particular machine or plant.

The whole matter is one of intelligent co-operation between seller and buyer, so that by the advice of the refiner's engineers, the knowledge of the manufacturer's experts and the careful and accurate testing of the plant, the service rendered will be demonstrated. Only in some such way can the matter be satisfactorily studied. The manufacturer's engineers know the plant intimately and thoroughly, and are sensitive to the least change in connection with it. The refiner's engineers know the oils and the work for which they are suitable. Consideration of the matter by both sides, checked up by careful and accurate testing covering the proper period of time, will determine the service and do it in such a way as to show the possibilities of conservation in the money effect of such study of lubrication.

AN ACTUAL SAVING

THE following is a Summary Report of tests made in a large plant of the Middle West by two engineers of The Texas Company, demonstrating, by comparison with well-known oils, the quality of lubricants marketed under the tradename of "Texaco," manufactured by The Texas Company of New York and Houston. These tests were undertaken with the understanding that, unless a marked increase in efficiency and a decrease in lubricating cost was shown, the management would make no permanent change in the matter of oils, as they were apparently well satisfied with the running of their plant, with the exception of one or two cases, wherein they encountered trouble from poor lubrication.

Through the entire plant reputable oils of considerable merit, from a well-known Company, were in use. However, they were not in every case particularly adapted to the mechanical conditions.

The purpose of these tests was to show the increased efficiency and decreased cost due to lubrication with "good oil," the oil most suited for the mechanical work to be done. Quite naturally, some improvement in efficiency is always to be shown when any one item, such as lubrication, is conscientiously studied and given expert consideration. The Texaco Oils, with the possible exception of the cylinder and crank case oils, are absolutely different, in nature, from the oils found in use, and consequently no comparison of satisfactory worth can be made by means of the usual laboratory *of physical test.* By this is meant a comparison as to viscosity, fire and flash, cold test or gravity. The peculiarity of the "Texaco" lubricants will be best noted by the way in which they stay on the different bearing surfaces, present a good lubricating film, and leave no deposit whatsoever, yet at the same time, produce a considerably lowering of bearing temperature from that obtaining when the former oils of lower viscosity, but made from different crudes, were used. This peculiarity is attributed to the particularly fine lubricating qualities of "Texaco" Oils, and the care taken in their manufacture.

All of the comparative results shown are taken from the readings made by three of The Texas Com-

pany's engineers. Wherever possible the tests were made upon individual units, not connected with a circulating system, supplying other machinery. For instance, the Power House was equipped with one twin, three simple, and one cross compound Corliss Engine, besides three air compressors. Of these, the only engine that was isolated from the circulating oiling system was the Ingersoll-Rand air compressor, which was tested separately. For the test on this compressor a careful record of the consumption of oils previously used and the temperatures of the different bearings, etc., was kept. All the oiling was attended to by regular plant employees, and both records of readings and of consumption of oils were checked by the Chief Engineer. No attempt was made to reduce the regular oil allowance for this compressor. The using of the proper grades of oil, as herein shown, made a decided saving.

Comparative Test made on Ingersoll-Rand Cross Compound Air Compressor

Size: Cylinders 20″ and 34″ diameter x 27″ stroke.

FORMER OILS	Room Temperature °F.	Right Bearing Temp. °F.	Left Bearing Temp. °F.	Frictional Temp. °F Right Bearing	Frictional Temp. °F Left Bearing
Average	90°	100°	103°	10°	13°
TEXACO OILS					
Average	82°	87°	90°	5°	8°

Frictional Temperature, (Average Temperature of the Bearing less the Temperature of Room)

	Former Oils °F	Texaco Oils °F	Reduction °F
Right Bearing	10°	5°	5°
Left Bearing	13°	8°	5°
Average, both Bearings	11.5°	6.5°	5°

Reduction in temperature of right bearing of 5 degrees or 50%.
Reduction in temperature of left bearing of 5 degrees or 61.5%.
Average reduction, frictional temperature of 5 degrees or 43.5%.

The amount of oil used in the crank case on the engine driving the air compressor for thirty days was four gallons of cylinder oil and twenty-eight gallons of engine oil with the former oil used. Here is an instance of mixing oils to secure the proper body. It had been the engineer's practice, formerly, to add cylinder oil to the engine oil, this being done to thicken the competitor's engine oil, so that more oil would be carried up by the crank disk and wiped into an overflow, which in turn furnished the necessary oil to lubricate the pillow block bearings and the eccentrics.

It has been customary in nearly all of the large plants which have for years bought the light viscosity Engine Oils to make a mixture of these oils with Cylinder Oils, in order to secure an oil of heavy enough body to lubricate properly the larger machines. This general practice is very costly. In the present case the cylinder oil is rather expensive. Mixing the two oils at the plant requires time and some expenditure in order to do it properly, and if it is not done properly the entire object is more or less defeated as the oils are very liable to separate, and in any event, a mixture may be considered as being nothing more than a makeshift which the plant operators have found necessary in order to use the oils purchased by their company. In the lubrication of this air compressor the Texaco Valor Oil had sufficient body to properly take care of the conditions without the admixture of any cylinder oil, and the use of this oil resulted in a reduction of 17.4 per cent. in the cost of lubrication. Practically as much of it was used as was used of the engine oil and cylinder oil mixture. Further, the cost of Texaco Valor Oil was the same as the cost of the former engine oil, which was found to be too light for the work. The reduction of 17.4 per cent., therefore, represents the value of leaving the cylinder oil out of the proposition, if such a thing could have been possible with the former engine oil.

During August and September, a careful account was kept of the consumption of cylinder oil in the Power House. It was found that 3.3 gallons of the competitive cylinder oil was necessary for a day's run of twenty-four hours. On the first of October the cylinder heads were removed from the Corliss Engine and the cylinders examined. Conditions were found to be rather good, no excess of oil being shown.

Texaco Cylinder Oil was then placed in the lubricators. During the month of October the consumption of oil averaged 1.894 gallons per twenty-four-hour day. Inspections at the end of this time indicated that sufficient oil was being fed for good lubrication.

Results of this Cylinder Oil test were as follows:

Oil Used	Gals. per 24-hr. Day
Competitor's Cylinder Oil .	3.3
TEXACO CYLINDER OIL . .	1.894
	1.406

Reduction in gallonage
1.406 or 42.5%

Reduction in cost
\$.3872 or 41.9%

The following figures were secured through a comparative test made on the bearings and guides of a Corliss Engine lubricated during the first test with the regular engine oil used at the plant, and during the second test with Texaco Oil. The detail figures are as follows:

Temperature Test on a Corliss Engine

Size: Cylinder 28″ diameter x 54″ stroke. 90 revolutions per minute.

Former Oil

Time	Room Temperature °F.	Right Bearing Temp. °F.	Left Bearing Temp. °F.	Guide Temperature °F.
9.00 A.M.	86°	106.5°	118°	114°
9.30 A.M.	86.5°	106.5°	118°	114°
10.00 A.M.	86.5°	106.5°	118°	114°
10.30 A.M.	88°	107°	118.2°	115°
Average	86.7°	106.6°	118.05°	114.2°
Frictional Temperature . .		19.9°	31.35°	27.5°

Texaco Oil

Time	Room Temperature °F.	Right Bearing Temp. °F.	Left Bearing Temp. °F	Guide Temperature °F.
9.00 A.M.	84°	91°	108°	101°
9.30 A.M.	85°	91.3°	108.4°	101.2°
10.00 A.M.	85°	91.3°	101.4°	101.2°
10.30 A.M.	86°	92.1°	109°	102°
Average	85°	91.4°	106.7°	101.3°
Frictional Temperature . .		6.4°	21.7°	16.3°

Frictional Temperature

	Former Oil °F	Texaco Oil °F	Reduction °F
Right Bearing	19.9°	6.4°	13.5°
Left Bearing	31.35°	21.7°	9.65°
Guide	27.5°	16.3°	11.2°
Average	26.25°	14.8°	11.45°

Reduction in Frictional Temperature, 11.45°F or 43.61%.

The temperature tests on the No. 1 St. Louis Simple Corliss Engine, Cylinder 26-inch diameter by 48-inch stroke, 66 revolutions per minute, connected to the circulating system, showed a reduction of 2.95°F. on the right bearing, of 2.25°F. on the left bearing, and 5.55°F. on the guide simply by the use of Texaco Oil. The frictional temperature of the different bearings was reduced 2.78°F. or 26.5 per cent. The reduction being in favor of Texaco Oil. The temperature of the room was 1.70°F. in favor of the saving.

Comparative Test Made on 6-Inch Shafting Bearing (Oil Ring Type)

FORMER OIL

	R.P.M	Room Temp. °F	Bearing Temp. °F.	Frictional Temp. °F.
I Test-Cylinder and engine oil mixed . .	256	80°	113°	33°
II Test-Engine oil	256	81°	113°	32°
TEXACO OIL				
III Test-Texaco Valor	256	82°	109°	27°

Reduction in Frictional Temperature between first and third test—
6°F. or 18.18%

Reduction in Frictional Temperature between second and third test—
5°F. or 15.6%

The above test was begun by using the mixture of cylinder and engine oil of the competitor's make. This mixture, however, was changed to engine oil alone later on. A reduction in frictional temperature by the use of Texaco Oil in the first case was 6°F. or 18.18 per cent. and in the second case 5°F. or 15.6 per cent.

The tests on the other engines in the Power House showed similar frictional temperature reductions, but the limits of this little book will not permit of publishing all of them in table form; a general summary will, however, show what has been accomplished.

In the Electrical department a comparative test made upon a motor was rather interesting. Here a mixture of cylinder and engine oil was used in the ring oil bearing. It was considered that the engine oil was not heavy enough to do the work. This mixture was eliminated by selecting the proper Texaco Oil, which gave the desired results of decreasing the cost 38.93 per cent; and reducing the actual frictional temperature of the bearings 12.5 per cent.

In the Crane department, tests were made upon thirty cranes which had previously been operating on a special crane oil, a good lubricant, but misplaced for this work, and much too expensive for work of this character. During the test with Texaco Oil, two additional cranes were operating, one during the day, and an additional one at night. Each test was based upon a 168-hour run, oiling was attended to by the individual operators. The result was a saving of 34.1 per cent. cost with Texaco Oil.

In the machine shop considerable difficulty had been encountered in properly lubricating the planer ways, for an undue amount of cutting had been experienced on the way facings. Cylinder oil had heretofore been used for this work, but not with the desired results. Texaco Crusher Oil was used upon one large and three medium sized planers with excellent results, noticeably the elimination of the cutting, and a saving in cost of lubrication of 62.6 per cent. The cylinder oil heretofore used was very expensive and due to the fact that it was poorly selected for this work, an excessive amount of it was required. Even then the results were "poor lubrication."—This explains why Texaco Oil was successful in a measure in producing such a large reduction in cost.

In the machine shop comparative

tests were made on lathes, planers, drill presses, boring machines, and shapers, with the use of Texaco Lubricants, the results of a week's run showed a reduction of 3.625 gallons or 29.5 per cent.; a saving of 23.4 per cent. in cost.

The oiling of the sand mixers was done without any instructions whatsoever, and a reduction in cost of 10.3 per cent. was shown. This method of procedure was used to see if the oilers in handling a new oil, would adapt themselves to its possibility and feed it accordingly. With instructions covering a period of 168 hours, the gallonage was cut down by 31.25 per cent. showing the value of supervising the introduction of a new oil. A test of Texaco Cylinder Oil upon the yard locomotive, on which a mixture of cylinder and engine oil had previously been used to lubricate the guides, crank boxes, and links, resulted in a decrease of 54.6 per cent. of the amount used. The engineer reported a decided difference in the running of his machine, and commented upon the ease of throwing his reverse lever, which proved to him that Texaco Cylinder Oil was lubricating his valves and rods with a decrease in friction. This simply proved again that an oil selected to meet the operating conditions, and properly applied, will increase the machine's efficiency and reduce the cost of lubrication.

The summary results of all tests, shown tabluated on the following page, represent the figures arrived at throughout the entire plant.

Summary

	Temperature Reductions	Gallonage Reductions	Reductions in Cost
Power house			
Twin Corliss, 31½″ x 42″	46.8%		
Simp. Corliss, 26″ x 48″	26.57%		
Simp. Corliss, 28″ x 54″	43.61%		
Cross comp. Corliss, 20″ x 34″ x 27″	56.52%	11.76%	17.4%
Cylinder oil		42.5%	41.90%
Engine oil (circulating feed system)			12.2%
Line shafting	18% and 15.6%		
Electrical dept.			
Motors (56 in all)		12.5%	38%
Cranes (2 more than with the former oil)			34.1%
Mechanical dept.			
Sand mixing, 1st week	Increase	14.06%	10.3%
Sand mixing, 2nd week	Decrease	31.25%	43.7%
Moulding dept., 1st. week	Increase	34.2%	4.8%
Moulding dept., 2nd week	Decrease	14.8%	43.9%
Power hammer		8.3%	30.7%
Machine shop, 1st week		29.5%	23.4%
Yard dept.			
Drop hoist (10 hour basis)		25%	63.8%
Locomotive No. 3 (24 hour basis) .		54.6%	58.6%
Yard crane No. 2		25%	24.9%

TEXACO CRATER COMPOUND

AN interesting test, experienced at the plant of one of the largest cereal manufacturers in this country, again points to the phenomenal results obtained with Texaco Crater Compound. This oil has shown up just as well under similar conditions, so this instance will no doubt be of interest to others than those whose business leads them to the lubrication of Flaking Machines.

These machines, six in all, are of Allis-Chalmers make, and have two rolls each, 18-inch by 24-inch, made of chilled cast steel, ground absolutely true, through whose center runs a forged steel shaft, each end of which has a bearing surface of 5¾-inch by 14-inch. These rolls revolve at 256 revolutions per minute and are used for flaking steam-cooked corn, which operation requires perfect adjustment at all times.

The split-bearing brasses are placed on the shaft so that the openings between the brasses are at an angle of about 45 degrees with the horizontal position of the shaft. Each roll has its own pulley wheels attached on opposite sides of the machine, whose belt runs in a direct vertical position. The inner surface of the bearing fits very closely to the roll, thus prohibiting the possibility of a wiper or guard of any description being placed between the bearing and the roll. The best grade of babbitt obtainable is used. The average temperature on the rolls is between 175 and 180 degrees Fahrenheit, which tempera ture causes considerable heat to be radiated to the shafts and bearings.

When our engineer made an inspection of this plant the boxes were packed with a good grade of competitive grease, manufactured by a local concern. This grease, so the cereal people claimed, had kept down the temperatures of their bearings and offered better lubrication than anything which they had used. Against this grease a test was made with Texaco Crater Compound, an oil of greater viscosity made from an entirely different crude oil base than that used to produce the competitive grease. This test was run in order to show the temperature reduction possible through the use of Texaco Crater Compound, and its suitability to this class of work. It was impossible to secure an accurate amount of competitive grease consumption, so no comparison could be made in this regard.

Several things, however, need consideration in the installation of any oils or greases for this work. The peculiar construction of the boxes allows the grease when melted to run from the end of the box, carry along the edge of the roll and drop into the flake chute, in which the flakes, after passing through the rolls, are carried to the packing room. With the use of suet or grease it was found that, even with the higher temperatures, not as great an amount of either would carry over the chute as of oil; and furthermore, when the suet or grease did carry over, it would not show in the flakes, being considerably lighter in color, while oils, in general, would cause a discoloration of the flakes, and thus damage considerable stock. A number of means had been tried to overcome this trouble, such as packing the space between the bearings with oakum, but the grease would soon soak through this and of course, oil would pass through even more readily; plaster of paris had also been tried, but the vibration of the machine rendered this impracticable. This trouble could be remedied by ma-

chining away a sufficient amount of the bearing to permit of a wiper or guard of some kind being inserted between the bearings and the rolls. The chief difficulty with greases, black oils, etc., is their general inability to withstand excessive heat conditions, and their general inability to adhere to the rolls and bearings.

Texaco Crater Compound, due to its great adhesiveness, would successfully take care of this condition, and as the following figures show, although Texaco Crater Compound was much heavier, as far as viscosity is concerned, than any of the competitive oils and greases, it allowed the bearings and rubbiug surface to run cooler than when lubricated with the lighter bodied lubricants.

Machine No. 1 was selected for the test, as the bearings on this unit had given more trouble than all of the others, particularly one, which was badly worn and needed re-babbitting.

This machine was started at 8.30 A. M. with the boxes packed with grease furnished by a local concern, which was claimed to serve their purpose best. After running for an hour the bearings which were selected for the test began smoking badly and the temperature registered above 240 degrees Fahrenheit. The grease was removed and the boxes packed with suet, which did not materially reduce the temperature. After a sufficient time to show temperature reduction, the suet was removed, while the machine was in motion, (which probably increased the temperature) and the boxes were packed with wool waste saturated with Texaco Crater Compound. After running for thirty minutes, the smoking ceased and the temperature readings registered 220 degrees Fahrenheit. The following regular temperature readings were then taken as given below:

Time	Room Temperature °F	No 1 Bearing Temp. °F	No. 2 Bearing Temp. °F
10.00 A.M.	70°	220°	200°
10.30 A.M.	71°	200°	197°
10.45 A.M.	75°	194°	190°
11.30 A.M.	77°	190°	190°
12.30 P.M.	78°	190°	190°
1.00 P.M.	78°	190°	190°
1.30 P.M.	78°	190°	190°
2.00 P.M.	78°	190°	190°
2.30 P.M.	78°	192°	198°
3.00 P.M.	75°	191°	194°
3.30 P.M.	75°	190°	190°
4.00 P.M.	75°	190°	190°
4.30 P.M.	72°	190°	190°
5.00 P.M.	72°	190°	190°

NOTE — The rise of 8 degrees in temperature on No. 2 Bearing at 2.30 P. M. was caused by forcing the waste packing down too close to the shaft; as soon as the waste was loosened up the temperature became normal.

By the above figures it will be seen that Texaco Crater Compound brought the temperatures down to a normal condition within a very short time, and maintained them until the end of the test.

During the test on No. 1 machine the pulley bearing on No. 2 machine began smoking badly and throwing grease in all directions. The grease was melting and running from the end of the box into the flake chute.

Texaco Crater Compound was applied and within an hour the temperature was down to 190 degrees Fahrenheit, which average was maintained until 5 P.M., when the test on Machine No. 1 was discontinued.

During the running of our tests, one of the largest oil companies had an expert working with their products in this mill. All kinds of greases were used by him, none of which would run for any length of time without having to be removed and suet used; and even with the use of suet, and with the grease, which they are now using, a number of the bearings burned out. It was noticed, that whenever the temperatures on the shaft would get high enough to cause them to smoke, that this condition would pertain for a long time and that it was necessary for the operator to refill the boxes with grease a number of times to overcome this Even with this precaution it was never known at what minute the temperature would reach a point where the babbitt would be melted from the bearing.

A number of large refining and oil companies have attempted to lubricate these bearings, but none of them have been successful. The lubrication of these machines had been a source of great trouble, requiring the constant attention of one man, while in operation, to keep the bearings from melting, but with the introduction of Texaco Crater Compound, one application was found to suffice for several days' run, however, some means of holding the waste in place must be adopted in order to give the best results.

The results of the entire test are very logical, showing that Texaco Crater Compound, a heavy bodied oil, possessing good lubricating qualities, and capable of withstanding excessive heat conditions, can be used successfully on this class of work. Moreover, the consumption of Texaco Crater Compound was considerably less, than that of any other product used.

The repair man made it his business to pass the machine, upon which our test was being made, several times during the day. He was very anxious at first in regard to the possibility of the babbitt burning out with our product, but after seeing the result of several hours' run, he felt assured, and went so far as to state that he had never seen anything that would bring about the condition which Texaco Crater Compound had done in this instance.

UNCLE SAM'S GREATEST FIGHTING MACHINE AND TEXACO URSA OIL

A report by one of our engineers who attended the trials

WHEN the U. S. S. "Texas," with her 573 feet of length and 95 feet and 5-8-inch beam, came to a stop and dropped her mud hooks in Hampton Roads, Thursday, October 30th, there was practically completed the greatest fighting machine afloat to-day; and she will remain so until the 6c8 feet of the Battleship "Pennsylvania" slips down the ways into the James River.

The "Texas" is the latest of a long string of fighting craft to be built by the Newport News Shipbuilding & Dry Dock Company, of Newport News, Virginia.

The keel was laid April 17, 1911, and she was launched May 18, 1912. The contract period for the completion of this ship expires on December 17, 1913, and the time was made to cover a period of thirty-six months. Not-

withstanding labor troubles, shortage of material and other causes of delay, she is now practically ready for duty if called upon.

When the "Texas" is completed she will represent an investment of about $15,000,000.00. The "Texas" is mentioned as the most powerful battleship afloat. This means from a standpoint of armament and not displacement. The trial displacement of the "Texas" was 27,000 tons, mean draft at above displacement 28 feet 6 inches.

The "Rivadavia," which uses Texaco Ursa Oil for her main turbines and Texaco Cetus Oil for the auxiliaries, built for the Argentine Republic by the Fore River Shipbuilding Company of Fore River, Mass., has a greater displacement, but her armament is not as great.

The main battery of the "Texas" will be ten 14-inch, 45 calibre breech loading rifles. The secondary batteries will consist of twenty-one 5-inch. 51 calibre rapid fire rifles; four 3-pounders for saluting; two 1-pounder guns for boats; two 3-inch field pieces; two .030 calibre machine guns and four 5 x 21-inch submerged torpedo tubes.

The main engines of the "Texas," in which we have additional interest on account of their being lubricated with Texaco Ursa Oil, were designed by the Newport News Shipbuilding & Dry Dock Company and are a development from the type designed by the Bureau of Steam Engineering. They are the last word to date in the reciprocating engine line. These engines are triple expansion with double low pressure cylinders of the following dimensions:

High pressure 39 inches; intermediate pressure 63 inches, low pressure 83 inches, with 48 inch stroke, capable of developing 28,100 horse power at 128 revolutions per minute, with a steam pressure at boiler of 295 pounds and at throttle of 275 pounds. The steam is, of course, superheated.

The performance of these engines on the trial trip bears out our statement that they are the last word in engine building, as they improved on the performance of the "Delaware," built by the same company. The "Delaware" to date holds the record for economy and mechanical efficiency; made while using Texaco Ursa Oil in her forced feed lubricating system.

The engines of the "Texas" turn outboard when going ahead and are in separate water-tight compartments with a middle line bulkhead between. They are of the inverted cylinder direct acting type, with cylinders placed as follows:

Forward low pressure, high pressure, intermediate pressure and aft low pressure. The cranks of the two forward engines are opposite, as are the two aft ones. The bed plates are of cast steel, with forged steel columns, truss framed, supporting the cylinders.

The cylinders and chests are fitted with steam jackets, except the high pressure, where the superheated steam makes jacketing unnecessary. Steam is supplied to the jackets through reducing valves and drains to steam traps.

The high pressure pistons are of cast iron, all others of cast steel, and they are practically the same weight in order to balance.

The crossheads are of the single slipper type, lined with white metal. The guides are of cast iron with water circulation in the hollow backs. Connecting rods are of the tee end type, with brass boxes bolted on for crank and cross head pins.

The cranks shafts are in two sections, each section containing two cranks forged from one ingot. All valves are piston type, with balance cylinders fitted to overcome their inertia, one for the high pressure

and two each for the other cylinders.

The valve gear is Stephenson's with double bar links and slotted holes for linking up on the reverse shaft arms. The reversing gear consists of steam and oil cylinder, the oil cylinder acting as a brake.

The water service for the main engines is supplied from the circulating pump, and the water is pumped through the main bearing jackets and cross head guides.

The various reciprocating parts are fitted for gravity lubrication, as in the case of all others of this type except the "Delaware."

The "Delaware" was the first ship in our Navy to be fitted with forced feed lubrication, the only marine engine previously fitted in this way being on H. M. S. "Africa."

The forced feed system on the "Texas" is very complete and includes even the thrust collars. To this and Texaco Ursa Oil the Engineers of the Ship Yard attribute a large part of the high efficiency of the engines, as only a small per cent. of the indicated horse power was consumed by the friction of engine thrust bearings and shaft bearings.

Each engine is fitted with its own system of forced lubrication. Oil is supplied under a pressure of about 35 pounds to each main bearing, crank pin, eccentric, cross head pin, main guides and thrust.

Two tanks of about 600 gallons capacity each are installed in each engine room and these tanks are fitted with heating and cooling coils. To these tanks are connected three pumps, either of which can be used as a return or supply pump. The oil taken from the suction well is passed through four separate strainers before returning to the bearings. The supply lines are fitted in duplicate and are independent, so that if one breaks down there will be no cause for stopping. At each main bearing a radial hole is drilled through the wall of the crank shaft to the axial hole in shaft. Holes are also drilled through the crank webs, connecting these axial holes with holes in the crank pins. In the path of the axial holes annular grooves are cut in the white metal of bearings. Oil discharged from service pipe passes to the annular groove in bearings through radial holes to axial hole in crank, thence to axial holes in crank pins. From there the oil is forced through tubes secured to the side of connecting rods, into an annular groove in the cross head brasses and caught in annular caps, as it emerges from the cross head pins at their periphery. The oil is then led through short pipes and castings secured to the cross head to a box at the bottom of the guide slipper. This box is pierced with small holes so the oil is sprayed the full width of the guide as the cross head moved up and down. The tops of guides are capped with a casting and pipes lead the oil from that point to the oil tight tanks formed by the bed plate castings and the inner bottom of the ship.

Great care was taken to prevent oil being thrown against the piston rods or bottom of the cylinders, this being done to prevent the carrying of oil through cylinders back to the boilers, which the writer understands happened in the "Delaware." The arrangement on the "Texas" proved very successful in this respect. The engines were cased with galvanized sheet steel all around and for one-half of its height; that is, up to the second or working deck. In the casing were sight holes and handling doors as required.

A branch of the main feed line of forced feed system was led to main circulating pump's engine, which was encased as is usual in small compound engines of the Belliss type. Another branch of the system was led to the main thrust collars; each collar had three holes drilled leading to the surface of the "go ahead"

thrust. These holes were supplied from a small branch pipe from the main line and each small branch was fitted with 1-8 inch pet cock so that we could tell that each collar was receiving its share of Texaco Ursa Oil. Over the entire thrust bearing was fitted a light hinged casing, not so much with the intention of making an oil-tight job as to make a baffle plate and prevent an undue waste of oil.

Each main bearing is fitted with a thermometer, as is also the return pipe to supply tanks and the main feed pipe from pumps to bearings.

The advantage of a forced feed lubricating system has been fully demonstrated on the "Texas." The Engineers of the Newport News Shipbuilding & Dry Dock Company claim that it shows an increased mechanical efficiency of as much as 5 per cent. This will be quite an item, in addition to the saving of oil when a suitable oil is used. It is a very notable fact that in all of the trial runs of the "Texas" the highest temperature was 110° F.

The circulating water coming from the bearings was of practically the same temperature as on entering. You can readily understand that the lubrication must have been practically perfect to keep the temperatures down to the point mentioned, when at times the room temperature ran as high as 108° F.

Another new feature of this engine room was that of making the working or handling deck about one-third the height of the engine instead of the engine room floor. This enables the engineer to look down on the main working parts of his machine.

On the dock trial, beginning October 6th, we were assigned the port engine and our competitor the starboard.

The starboard engine had the first shake down and adjustment run, and it was noticed that our competitor's oil on this engine emulsified rapidly and showed that it would be hard for it to separate: in fact, it did not begin to separate until it had been at rest for twenty-four hours.

In the shake down run on the port engine Texaco Ursa Oil showed at once that it had a pronounced dislike to mixing with water and in a short time was showing clear water in the glass gauges on the settling tanks.

After the completion of the dock trial, October 10th, we were advised by Superintendent of Machinery N. Christiansen, that we had shown up so well that he would give us an order for 3500 gallons of Texaco Ursa Oil to use on the trial trip against our competitor's oil.

The "Texas" left Old Point, Monday, October 20th, at 8.15 A.M. for Rockland, Maine, to be standardized. On Tuesday we ran into rough going and the mess tables were extremely unpopular for about twenty-four hours. We arrived at Rockland on Wednesday, the 22nd, at 6.00 A.M. and "lay to" waiting for the "Navy Board."

The trials began on Thursday A.M. and consisted first of a progressive trial over a measured mile course, beginning at a speed of ten knots and finishing at the contract speed of nineteen knots. This run was successfully completed.

The second trial was to be at maximum speed, or full power, and was to be five times over the course. On the third lap of this run a valve stem on the forward low pressure cylinder of the port engine gave way and caused damage that delayed us until Monday, the 27th, when the maximum speed trial was completed, and the Shipbuilders could paint on the turrets 22.27 knots, which exceeded the contract speed by 1.27 knots.

Before leaving Rockland we were asked to furnish thirty-five barrels more of Texaco Ursa Oil and were able to do this with such promptness that the Ship Yard people were surprised.

The next trial was a four-hour, full speed trial in the open sea. Before beginning this run all of the competitive oil which could be spared was pumped overboard—really pumped overboard from the system of the starboard engine—and was replaced by Texaco Ursa Oil.

The four-hour full power run, the twenty-four hour 19 knot endurance run and the twenty-four 12 knot coal and water trials were successfully completed.

We then had a full speed trial of two hours, burning coal and Texaco Marine Fuel.

The guarantees on water consumption were:

20,000 pounds water per knot run at 21 knots.

14,210 pounds water per knot run at 19 knots.

7,420 pounds water per knot run at 12 knots.

The first two were made with a few hundred pounds to spare. The 12 knot guarantee was beaten by about 1,000 pounds.

Upon the return of the "Texas" to the Newport News Shipbuilding & Dry Dock Company both of the oil systems were thoroughly cleaned and they were refilled with Texaco Ursa Oil.

OIL AND FILTER SYSTEMS FOR POWER PLANTS

THE handling of oil in what is called Return, or Gravity Feed Systems is at present a very much discussed subject. The economical requirements in large power plants make it necessary to use a system that will lengthen the life of the oil, reduce labor charges, and at the same time maintain the efficiency of the station. There are a great many points of view, and those who are mostly at interest, that is, the manufacturers of large filter plants, have diametrically opposed opinions, judging entirely from the different installations that are in service either where the equipment is not sufficiently large enough to take care of the station, or where it is, has not been put in with proper care as to the engineering details that the importance of the question should demand. The filter buildings, as a rule, when making estimate for a filter or circulating system, figure this on the horse power of the station without inquiring into the conditions under which the oil will be subjected, how often it will have to pass through the system, whether water and dirt will come in contact with the oil and whether there are any facilities outside of the system, which they will install, for taking care of any oil that may be damaged by water. To take a concrete example, let us suppose an engine room properly built and well ventilated, located in a clean locality, with five engines of 5000 horse power total capacity, all directly connected to electric generators where proper attention is given to stuffing boxes and coolers, so that no water can get into the system; such a station can be considered quite ideal, and here the oil system can be put in on the basis of figuring horse power only. Further assuming that 600 gallons of oil are installed and that this amount of oil must pass through the system six times every twenty-four hours in order to hold the bearings at a normal temperature. At this rate of feed, which is not at all uncommon, the oil should hold up under conditions at this station for an indefinite length of time, practically a question of years, assuming however, that shrinkage is taken care of by the addition

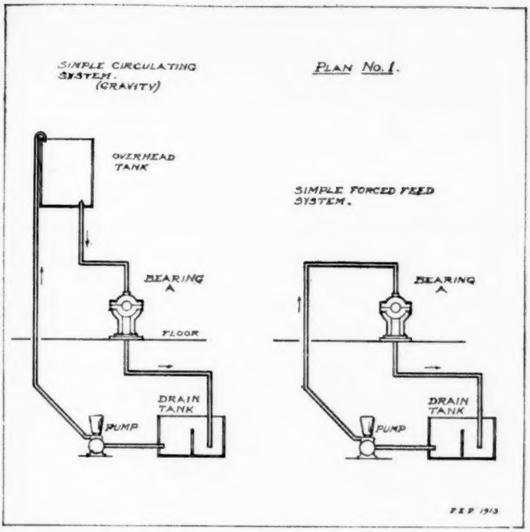
of a daily allowance sufficient to maintain six hundred gallons in the system at all times.

Aside from the ideal conditions previously described, conditions of this nature are more often encountered. In this case, an extreme example for comparison, an engine room of the same number of engines, same horse power, is more or less openly constructed, in the center of a rolling mill or blast furnace where there is nothing but dirt, smoke and dust; and added to this the practice, which is common in some plants, of washing down engines and floors with a one-inch hose or steam. And further, figuring that any oil used under these conditions will carry a great amount of water and dirt with it—that the effect on the bearings will be bad and that these bearings will wear to a point where they will require more oil than when new, it would be obvious that six hundred gallons of oil circulating six times in twenty-four hours would not be sufficient to lubricate all of the bearings.

The filtering or circulating system must be designed in such a manner that the water and dirt can be taken out of the circulating oil. In order to do this, it would be necessary that a large reserve supply of oil be kept in the same system that is used for lubricating the bearings; but this part of the system must be arranged so that the oil will be held as a reserve supply, and while being so held is being cleaned, heated or cooled as may be necessary. After it is in proper condition it should be shunted into the main system or on to the bearings so as to allow the working oil to be released and taken care of.

One point in connection with all circulating or gravity feed systems that must be borne in mind is that even the best oil will break down and lose its efficiency if it is constantly being circulated in connection with water and air under pressure. Engineers are slowly coming to the opinion that it is the water that gets into a Turbine Oil or general Engine Oil that causes the main difficulties, among these being the throwing out of deposit, this deposit getting into the oil ways and oil pipes and causing the oxidizing of parts and general loss of lubricating body. As the water is the chief offender, it is naturally coming to be the opinion of the same engineers that water filters should not be allowed in a system. In gravity feed or circulating systems, where filters are at present arranged, which have been built for the purpose of carrying water in the lower level of several compartments, good results have been obtained by taking out the water entirely and allowing nothing but oil to be in the tank. As a matter of fact, the old theory that the oil is washed in passing through the water has very little basis, as the oil will pass up in a globule,—the dirt remaining safely on the inside—or particles of dirt will be thoroughly coated with oil so that in passing through the water there is little effect. The main feature that has so long caused water to be held in a filter is the settling out of particles of heavier substances and their falling down through the water into the bottom. This settling out effect will be absolutely the same if oil is used instead of water and a much better result will be obtained, as the oil, if free from water in the first place will not be allowed to take up any small percentage of moisture in passing through the filter.

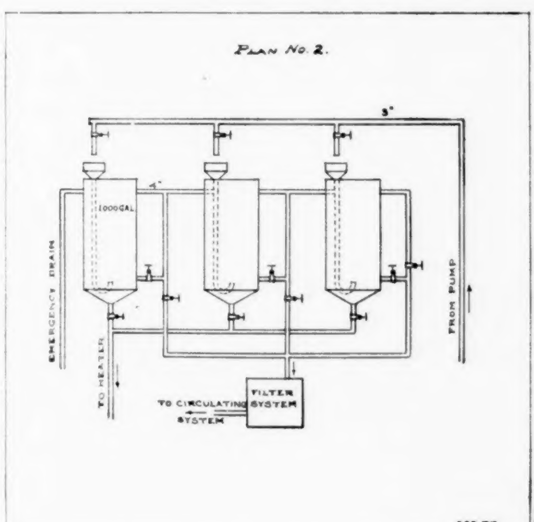
Before describing the two rather elaborate systems taken up at the end of this paper, it is just as well to show a very simple form of gravity feed or circulating system. This is shown by Plan No. 1, where *A* represents the engine or bearing to be lubricated. On this plan a tank is



placed on the engine room wall at as high a point as possible above the bearing. This is called the overhead tank. A drain tank is placed underneath the engine. The oil flows from the overhead tank into the bearing, from which it drains into the lower drain tank, from which it is taken by a pump and pumped into the upper tank. Wherever heaters, coolers or filters are desired, these can be placed anywhere between the bearings and the overhead tank. A considerable number of technicalities are involved in the placing of filters, heaters or coolers that are unnecessary to take up here. Should it be desired to work this system as a Force Feed System, the upper or overhead tank is cut out and the oil is sent directly from the pump to the bearing, from which it overflows into the lower drain tank, filters, heaters or coolers, this system being arranged as described previously.

In either of these two systems above represented, should water become mixed with the oil, it would be necessary to remove the oil from the lower tank, allow the water and dirt to settle, after which the oil will be practically as good as new. This will require what is known as a heating or settling tank, and in the case of small stations this tank can be installed wherever it is possible to get a steam connection for the coil. In the majority of stations it would be advisable to have a settling tank or heating tank connected to the system.

In Plan No. 2, which is the result of consultation of a great many engineers on a very difficult proposition where the most extreme lubricating conditions are to be met, a combination plan is shown. This system is, in the first place, designed to increase the capacity so that the

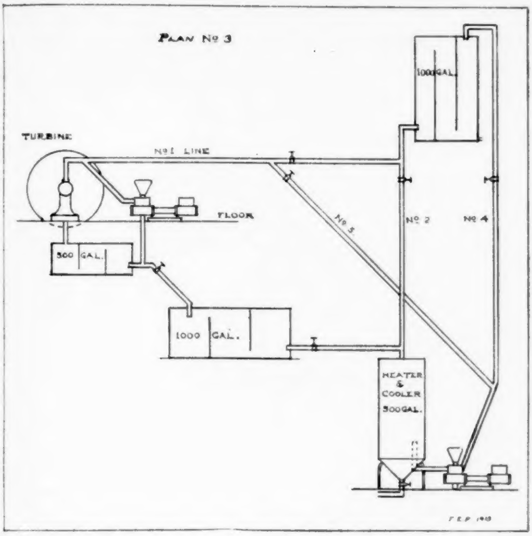


oil, while flowing at the same speed over each bearing to be lubricated, will not circulate rapidly through the entire system, but at regular points will have the opportunity for allowing the water and dirt to be properly settled. The three tanks are of 1,000 gallon capacity. The oil drains from all of the engines into a lower drain tank, from which it is taken by the pump and put into the header line which runs above the three storage tanks. There is a connection over each tank, and a pipe with curved end which can take the oil to the bottom of the tank. The tanks are connected near the top and near the bottom, and directly at the bottom of the cone. Valves are placed in all of these connections. The drains from the tanks are taken to the filter; from the filter the oil is taken by a second pump and passed to the overhead tank, from which it flows to the bearings. This tankage system, as will be seen by a close study of the plans, allows all of the oil in circulation to be divided into three parts. By opening the valves so that the oil is run into each of the three tanks, the oil can then go from the top of each tank directly into the filter; in this way each tank is being used as a large settling arrangement, and ample opportunity is given for any water and dirt to settle out and be drawn off from the cone-shaped bottoms.

A second plan of continual operation can be secured by throwing all the oil into the feed tank and thus using the three tanks as a continuous settling arrangement, whereby the oil is taken to the bottom of the tank and allowed to flow from the top of the tank to the bottom of the next, and so on, until it is taken to the filter. In this way three complete arrangements are provided for the settling out of water and dirt.

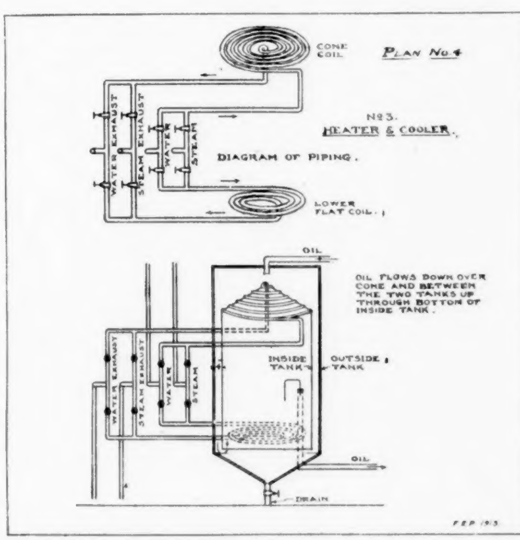
The third arrangement can be made by properly adjusting the valves so that one or two tanks are entirely taken out of the system and closed off, the remaining tank or tanks being in operation. Connected with the system and not shown in the sketch is a heating tank which can take care of one thousand gallons of oil. If the oil in the bottom of the three tanks is in bad shape, it can be drained off to the heating tank, the good oil reclaimed and the sludge sent to the sewer. Arrangement is made whereby the oil of any one tank can be treated at any one time. After the oil has been treated in the heating tank, it can be pumped back into the system. The method of operation of a station equipped with this system would be to hold one thousand gallons in complete reserve, circulating the balance of the oil until such time as it required treatment in order to remove the water and dirt, then a one thousand gallon tank of the circulating oil would be cut out, the other two tanks left in, one of which would contain clean oil, which would mean that the circulating oil had been improved by the addition of one-half clean oil. By repeating this process the circulating oil can eventually be brought around to a good condition.

A more elaborate system is shown in Plan No. 3. This system is at present installed in a large turbine plant, where the original installation put in by the turbine manufacturers consisted of the pump attached to the turbine and a five-hundred gallon surge tank. It was necessary to carry a reserve supply of oil at this station, and it was later found necessary to put in a heating tank in order to treat the oil which was taken from the turbine as it was found to contain a considerable amount of moisture after a short period of operation. The storage tank of one thousand gallons capacity was placed on the engine room wall as far above the floor as possible; and additional one-



thousand gallon storage tank was placed in the basement underneath the five-hundred gallon surge tank, and a special combined heater and cooler was placed where it could take care of the oil by gravity from all of the tanks. This combination heater and cooler is shown in Cut No. 4. This is arranged so that either steam or water can be put into the upper coil, the same in the lower coil; the oil, therefore, can be first heated, which will allow of quicker separation from the water, and afterwards, before passing back to the tank, the cooler coil will bring the oil back to the proper temperature. This order can be reversed if necessary, or the entire tank can be used as either a heater or a cooler, as circumstances may require.

Reverting to the complete system, this consists of an auxiliary overhead storage supply of one thousand gallons and a short circulating system of five hundred gallon tank and pump. The auxiliary reserve oil could be turned directly into the bearing through No. 1 line; the feed would be by gravity and the pressure would be sufficient to hold the turbine from seizing until it could be brought to rest. This system is used very largely in Europe. In turning on the overhead supply system the lines from the five-hundred gallon surge tank would be opened to the one thousand gallons settling tank; the heater could be started and the oil could be re-pumped to the overhead tank. In this way the outside system would be practically a gravity system with the surge tank, one thousand gallon settling tank, and heater acting as a drain tank. By a suitable by-pass from the lower pump the oil can be sent from the heater directly to the bearing, cutting out the overhead storage tank and making the system



operate on force feed directly from the pump. This installation allows the turbine to be handled in three different ways:

First:—By the short circulating system from the 500-gallon tank.

Second:—By the big gravity feed system where the oil is supplied to the bearings from the overhead storage tank.

Third:—By the shorter force feed system where the oil is supplied to the bearings by the lower feed pumps.

This arrangement also allows of quick work in cleaning the oil, in case of an accident whereby the oil becomes heavily charged with water. Details of this system are very finely worked out. The overhead storage tank and the lower one thousand gallon tank, as well as the five-hundred gallon surge tank, are arranged in combination, the oil in each case flowing from the top to the lower part of the tank and then over a second partition, giving it ample time to separate itself from the water and dirt.

By either of the two systems referred to in the latter part of this article it is unnecessary to have a filter composed of filtering bags or other material, as the heating spaces and facilities for bringing a certain portion of the oil absolutely at rest will allow all of the water and dirt to be removed from the oil without any difficulty whatever. The method of operation in both of the systems would be to alternate certain portions of the oil, so that part of the oil in the system is constantly at rest. By treating oil in this manner, keeping it free from dirt and water, and having arrangements whereby in case of accident the oil can be treated immediately without shutting down the plant, the greatest efficiency will be maintained, the oil will have the longest life and give the utmost limit of satisfaction.

Earthen Storage at Jennings (La.)